Journal of Mechanical Design

Guest Editorial

Special Section: Designing for Additive Manufacturing: Recent Advances in Design for Additive Manufacturing

Now in its 40th year of existence, ASME's *Journal of Mechanical Design* has covered a wide range of topics on behalf of the Design Engineering Division. The past 40 years have seen countless advances in mechanical design, developing new knowledge in areas ranging from simulation to representation to communication, among others. These advances have often been complemented by similar advances in manufacturing, and traditional manufacturing processes such as machining and injection molding have been investigated heavily by the engineering design community. Today, however, we are in the midst of a paradigm shift. Whereas design methods in the past sought to overcome the design constraints imposed by manufacturing technologies, emerging digital manufacturing processes are removing many of these barriers and introducing new ones that are not yet fully understood. As a result, the additional degrees-of-freedom offered via selective (multi-) material addition/subtraction have exceeded our current design proficiencies. Additive manufacturing (AM) is at the forefront of this shift, and our engineering design software, methods, and tools are struggling to keep pace.

As many readers know, AM provides unprecedented freedom for designing and engineering parts that are fabricated layer-by-layer. AM enables novel designs for a wide array of uses and applications in a range of industries, including aerospace, consumer goods, defense, energy, and medical, among others. Components can be easily light-weighted with topology optimization and lattice structures, complex assemblies can be consolidated into single 3D-printed geometries to reduce manufacturing complexity, and multimaterial fabrication techniques made possible by several AM processes enable never before seen functionally graded materials. In short, AM is changing not only what we design but also how we design, and a recent National Science Foundation Workshop on Additive Manufacturing Education and Training revealed that Design for Additive Manufacturing was the most pressing need for (re)training the engineering workforce. Consequently, this Special Section explores recent advances in the theories, methods, tools, and guidelines in Designing for Additive Manufacturing (DFAM). These contributions are empowering engineers to design and realize new parts, products, and systems that leverage AM processes' full capabilities, and in turn, are accelerating the adoption and application of AM technology.

This Special Section is the second of its kind within the *Journal of Mechanical Design*, following the 2015 Special Issue: Design for Additive Manufacturing: A Paradigm Shift in Design, Fabrication, and Qualification. Since the previous issue, AM has maintained a high level of interest and continues to flourish as design and manufacturing technology have advanced at a feverish pace. America Makes, the first Manufacturing USA Institute, remains a strong advocate for AM technology, providing numerous partnership opportunities for industry and academia to join forces to help accelerate AM adoption. The Additive Manufacturing Standards Collaborative has documented the needs for Design for AM standards and development. Meanwhile, DARPA's transformative design (TRADES) program was established to advance the foundational mathematics and computational tools required to generate and better manage the enormous complexity of design in today's increasingly digital manufacturing environment. Finally, companies like Autodesk, Dassault, Parametric Technologies Corporation, and Siemens are in a neck-and-neck race to field integrated computer-aided design, modeling/simulation, and process planning software support for AM.

Like the previous special issue, we have aimed to present readers with state-of-the-art research regarding DFAM in this special section. The papers in this special section can be categorized into three broad categories: (1) Review of State-of-the-Art, (2) Advances in State-of-the-Art, and (3) DFAM Case studies. Together, these papers highlight the advancements made in the past 2 years in DFAM in the engineering design community. This snapshot of where we currently stand as a design community, and how AM technologies are driving advances in new design paradigms and industrial applications, demonstrates how far we have come within a short period of time. The industrial adoption of AM continues to expand, with numerous companies now using AM processes to produce end-use artifacts in large quantities. AM technologies and material capabilities have continued to rapidly improve, and in turn, have continued to spur new opportunities for design theory, methodology, and automation.

We expect that this will not be the last Special Issue or Special Section on Design for Additive Manufacturing—only the latest. As industry increasingly recognizes AM as viable production technology and integrates it within their existing manufacturing process chain, the need for expanding the mechanical design capabilities for engineers is sure to follow.

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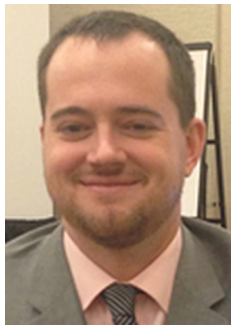

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